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P4.085 Investigations on stable operational regions for SPIDER RF oscillators

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The SPIDER experiment, currently starting to operate at the Neutral Beam Test Facility (NBTF) in Padova, is the full-size prototype of the radiofrequency (RF) ion source for ITER Neutral Beam Injector (NBI). It features a 1MHz RF system including 4 generators, each one rated for delivering up to 200kW of RF active power. A single generator is composed of 2 tetrodes connected with the push-pull configuration. Its load is made of a 30m long coaxial transmission line plus the plasma driver with its matching box. The selection of free-excited oscillators for the RF generators of ITER NBI ion sources was done on the basis of the experience at IPP laboratory suggesting to prefer that technology since it allows operation against variation of the load over a wide range. However, more recent experience at IPP reports on the observation of so-called “frequency-flip” phenomenon, i.e. a sudden frequency variation of the oscillator. Moreover, the site commissioning tests of the SPIDER-RF generators showed that, under certain mismatched load conditions, an amplitude modulation of the fundamental harmonic rose up leading to unstable operation. So, studies have been carried out in order to understand the causes of such instabilities. Three models have been developed for the SPIDER-RF system: a full transient model, a phasor-based model and a state-space model with eigenvalue analysis. With the aid of such complete set of models, it was possible to reproduce, understand and fix the causes of the modulation. Moreover, the models predict that also SPIDER could be affected by the “frequency-flip”. Nevertheless, the eigenvalues analysis explains the causes of the flips and the phasor model defines safe operational regions for the generators. The paper will report on the studies and models development to understand the behaviour of SPIDER-RF oscillators and to investigate on the achievement of stable operating conditions.

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